

SPECIFICATIONS FOR  
VEHICLE EXHAUST GAS ANALYZER SYSTEMS  
FOR USE IN  
THE TEXAS VEHICLE IDLE EMISSIONS  
INSPECTION/MAINTENANCE PROGRAM

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## **TECHNICAL AND PERFORMANCE STANDARDS**

These specifications provide the technical and performance standards for the exhaust emissions analyzer required by the State of Texas for use in the vehicle idle inspection/maintenance program. All design, performance, and administrative requirements are incorporated, by reference, in Texas Air Control Board Regulation IV, Control of Air Pollution From Motor Vehicles (31 TAC Chapter 114).

These specifications are divided into the following sections:

- A. GENERAL
- B. CONSTRUCTION DESIGN
- C. OPERATIONAL DESIGN

### **A. GENERAL**

#### **A.1 Design Goals**

The specifications have been designed around a personal computer system to provide the capability to make modifications which are needed after the analyzers are put to use. Features of the analyzer will include: vehicle emission measurements of hydrocarbon (HC), carbon monoxide (CO), and carbon dioxide (CO<sub>2</sub>) (oxygen (O<sub>2</sub>) shall be offered as an option); engine RPM measurements; exhaust dilution determinations; data entry; a dedicated printer for vehicle inspection reports and other general purpose printouts; data recording on standard 1.44 megabyte (Mb) 3.5" floppy diskettes and 40 Mb hard disk; information display to the operator; and fully menu driven, interactive simple microprocessor controlled operation.

Additionally, automatic features required by the specifications described herein include: gas calibrations, leak checks, HC hang-up checks, test averaging (i.e., read system), test sequencing, and a low-flow lockout capability. The analyzer shall be designed and constructed to provide reliable and accurate service in the automotive repair and service center environment. The software used in the analyzer shall consist of a process control system as well as data lookup files. Security shall be provided that will prevent any unauthorized modifications of the software.

The emissions analyzer shall be designed for maximum operational simplicity with a minimum number of operational decisions required in the performance of a complete exhaust emissions analysis. It shall also be capable of providing emission characteristics, independent of the inspection function, which can be used for vehicle diagnostic work as well. The purchase of a separate diagnostic system or component is not required.

#### **A.2 Useful Life**

The useful life of the analyzer shall be a minimum of five years.

#### **A.3 Nameplate Data**

A nameplate with provisions for and including the following data shall be permanently affixed to the housing of the analyzer:

- Name and address of manufacturer
- Model description
- Serial number
- Date of assembly

After installation, the manufacturer shall affix a stick-on type label to the analyzer which contains a toll-free telephone number for customer service.

#### **A.4 Manuals**

Each analyzer shall be delivered with one each of the following manuals:

- a) Easy Reference Operating Instructions
- b) Operation Instruction Manual
- c) Maintenance Instruction Manual
- d) Initial Start-up Instructions

The manuals shall be constructed of durable materials and shall not deteriorate as a result of normal use over a five year period. The analyzer shall provide convenient storage for each manual in a manner that will:

- a) Allow easy use
- b) Prevent accidental loss or destruction

#### **A.5 Warranty Coverage**

A written warranty coverage agreement, signed by an authorized representative of the equipment manufacturer and the vehicle inspection station owner or operator, which provides complete coverage of parts and labor for all systems and components and all manufacturer provided services listed in Section A.6 of this specification must accompany the sale or lease of each approved emissions analyzer. The warranty agreement shall include the inspection station owner's name, full station address and telephone number, station identification number, and terms of the agreement. The agreement will extend for one year with guaranteed renewals provided at the station owner or operator's request for at least five years.

#### **A.6 Manufacturer Provided Services**

The manufacturer or its authorized representative shall agree to provide the following services to the inspection station as part of the one-year warranty and thereafter upon request by the station owner or operator at a cost negotiated between the company and the customer:

- a) Delivery, installation, calibration, and verification of the proper operating condition of a vehicle emissions analyzer which has been approved by the Texas Air Control Board (TACB).

- b) Quarterly examination, calibration, and routine maintenance of the analyzer and sampling systems including replacement or cleaning of filters, hoses, etc.
- c) Training of all certified inspectors employed by the station at the time of installation in the proper use, maintenance, and operation of the analyzer, including the step-by-step procedure for performing a vehicle idle inspection in Texas. Additional training of new inspectors must also be provided within 45 days of an oral or written request from the inspection station operator. The analyzer shall contain a feature that will allow a mechanic or student to go through the complete inspection procedure without generating an official inspection record. This capability will be used by Texas Department of Public Safety (DPS) representatives for evaluating mechanic performance, by the manufacturers for training purchasers of analyzers or by station owners to train new employees. The training application shall not require the use of a mechanic's access code or allow access to secured areas of hardware or software. The ability to utilize the training application may be limited by the owner of the analyzer. The display shall show a message throughout the inspection that this is a training exercise and not a test for certification. Vehicle inspection reports shall indicate to the satisfaction of the TACB that they are for training only and cannot be used for certification.
- d) On-site service response by a qualified repair technician within two business days of an oral or written request from the inspection station operator. The names, toll-free telephone numbers, and business addresses of all manufacturer representatives responsible for equipment service in the affected county shall be provided to the inspection station operator for this purpose. A service representative shall be available at all times during normal working hours. Sundays and national holidays are not included. All system repairs, component replacements, and/or analyzer adjustments, including correction and reset of quality control lockout systems, shall be accomplished on-site within one day after authorization has been obtained to perform the needed repairs. If the completion of this work is not possible within this time, a temporary replacement unit meeting all program requirements shall be provided until the malfunctioning unit is properly repaired and returned to service.
- e) Annual updates of software may be specified by the TACB. Extensive modifications or additions are not anticipated. Areas in the software where changes or additions might be required include: preconditioning procedures and emission test sequences, various lookup tables, data communication procedures, criteria affecting emission standards selection, vehicle exemptions, and vehicle pass/fail criteria. Other areas not specifically mentioned may also be impacted at some point, but changes are not expected in all these areas at once. Major alterations or additions to the analyzer hardware or software design may occasionally be necessary in response to changing program requirements, vehicle technology, etc.

A software version number, consisting of a four digit alphanumeric code to be made up of the last two digits of the year followed by a two digit version number, shall be recorded in the analyzer and included on each vehicle test record. The version number of the software used in running every vehicle test shall be indicated on the test record. The analyzer manufacturer shall notify the TACB in writing of every software modification made which results in a change in the software version number.

All TACB required software updates done by the manufacturers shall cause the software version number to change. There will be a separate field on the test record indicating the software version currently in use and another field used to indicate the version number that the software will be updated to when the clock activates it. The effective date of all changes will be established by the TACB and must be preset into the analyzer to ensure that all analyzers automatically convert to updated program criteria simultaneously. A search of the records prior to the effective date shall determine how many analyzers have been updated by looking at the update field. The update field in the test record shall go blank when the update is activated.

The TACB reserves the right, at any time, to acquire analyzers currently in use at licensed stations for the purpose of evaluating compliance with the certification specifications. The TACB may also require the manufacturers to conduct on-site or laboratory testing of a sample of in-use analyzers in order to document continued compliance. When an analyzer is pulled from the field, manufacturers shall supply the station from which it was removed with a temporary replacement unit meeting all program requirements. Manufacturers shall pay for all necessary shipping and transfer costs for the replacement and the analyzer selected for random testing. Manufacturers shall also pay for any required testing performed by their personnel or by an independent company.

The manufacturers shall provide training to DPS and TACB personnel on all operational, maintenance, and quality control features of the analyzers, including full access to and use of inspection, state, and service menus, as well as optional programs offered to station operators. Such training shall be conducted at the manufacturer's expense as a requirement of certification and thereafter at reasonable intervals upon verbal or written request by the state.

#### **A.7 Certification Requirements**

The manufacturer shall submit a formal certification to the TACB that states that any analyzer sold or leased by the manufacturer or its authorized representatives for use in the Texas vehicle idle inspection/maintenance program will satisfy all design and performance criteria described in these specifications. The manufacturer shall also provide sufficient documentation to demonstrate conformance with these criteria including a complete description of all hardware components, the results of appropriate performance testing, and a point-by-point response to specific requirements. Previous certification by the TACB or the California Bureau of Automotive Repair (BAR) may be considered in this process but will not be sufficient to satisfy all necessary documentation requirements.

In addition, a full description of the company's service procedures and policies, as well as sample contracts, warranties, and service agreements, shall be provided as part of the certification application to ensure proper maintenance of all analyzers throughout their useful life. A fully functional analyzer shall be presented for examination and testing by the TACB.

All manufacturer-supplied software shall be properly documented. A copy of the documentation shall be submitted to the TACB as part of the certification application. The complete program listings need not be submitted with this documentation. However, manufacturers shall agree, in writing (signed by the Chief Executive Officer of the company), to submit copies of the program listings, including the source code as well as object code in both machine readable and paper form, to the TACB upon request, within a reasonable time frame to be determined by the TACB, or whenever a decision is made by the manufacturer to voluntarily suspend or terminate production of the analyzer. Software documentation shall include the following:

- a) functional specifications;
- b) functional flow charts of the manufacturer's software;
- c) sample inputs and outputs from all processes; and
- d) detailed interface information on the bench interface to include calling protocol and output specifications.

Documentation provided by the manufacturer to meet this requirement will be treated as proprietary information by the State provided such material is clearly marked as confidential. Marking all materials and documents as confidential shall be unacceptable. Only specific materials and documents considered to contain proprietary information shall be marked as confidential.



## **B. CONSTRUCTION DESIGN**

### **B.1 Materials**

All materials used in the fabrication of the analyzer and the appropriate housing assembly shall be new and of industrial quality and durability. Contact between non-ferrous and ferrous metals shall be avoided where possible. Suitable protective coatings shall be applied where galvanic action is likely. All mechanical fasteners shall have appropriate locking features. Use of self-tapping screws shall be avoided. All parts subject to adjustment or removal and reinstallation shall not be permanently deformed by the adjustment or removal/reinstallation process and this process shall not cause deformations to adjoining parts of the equipment. Only materials that are not susceptible to deterioration when in contact with automobile exhaust gases shall be used.

### **B.2 Construction**

The analyzer shall be complete and all necessary parts and equipment required for satisfactory operation shall be furnished. A suitable means of storing the probes and sample hose shall be provided. All parts shall be manufactured and assembled to permit the replacement and/or adjustment of components and parts without requiring the modification of any parts or the basic equipment design. Where practical, components and/or subassemblies shall be modularized. The analyzer cabinet finish shall be baked enamel or equivalent.

### **B.3 Mobility**

The analyzer unit shall be designed for easy and safe movement over rough surfaces (3-inch deep holes) and/or graded surfaces (15° incline). The center of gravity and wheel design shall be such that the analyzer can negotiate a vertical grade separation of ½ inch without overturning when being moved in a prescribed manner. Industrial grade, swivel casters shall be used to permit 360° rotation of the unit. The caster wheels shall be equipped with oil resistant tires and foot operated brakes capable of preventing movement on a 15° incline.

### **B.4 Electrical Materials/Construction**

Unless otherwise specified, all electrical components including motors, starters, switches, and wiring shall conform to provisions established by the Underwriters Laboratories, National Electrical Code, and applicable state and local electrical codes.

The analyzer shall operate from unregulated 120 volt, 60 hertz (Hz) supply. An input voltage variation of from 100 to 130 volts and +1 Hz frequency variation shall not change analyzer performance more than 1% of full scale. The maximum power requirement is 15 amps. The power cable shall be equipped with a standard three-prong connector at the inlet, and shall have a National Electrical Code rating of SO, SJO or better. Each analytical system and the entire emissions analyzer shall incorporate safety devices to prevent conditions hazardous to personnel or detrimental to equipment. The system shall be grounded to prevent electrical shock, and adequate circuit overload protection shall be provided. The analyzer shall be sufficiently protected from voltage surges to prevent damage to the analyzer from the simultaneous start-up of a 220 volt compressor, an arc welder, hydraulic controls, and other equipment commonly found in a commercial garage.

## B.5 Sampling System

The sampling system consists of two subsystems: (1) external sampling subsystem; and (2) internal sampling subsystem. The external subsystem shall include a sample probe, sample hose at least 20 feet in length, a water trap, and a filtration system. The internal subsystem shall include, but not necessarily be limited to, a sample pump and bypass pump, or an equivalent system approved by the TACB.

The sample probe shall incorporate a positive means of retention to prevent it from slipping out of the tail pipe when in use. A thermally insulated, securely attached hand grip shall be provided on the probe in such a manner that easy probe insertion using one hand is ensured.

The probe shall be flexible enough to extend into a 1½" diameter tail pipe having a 3" radius 90° bend, 4" from the end of the pipe. The probe shall allow an insertion depth of at least 12 inches from the end of the tail pipe or tail pipe extender. All flexible materials used in the probe construction shall be of a sealed construction to prevent sample dilution. The probe assembly shall be replaceable as a unit separate from the sample line.

The probe shall also have a smooth surface near the probe tip before the flexible portion of the probe to be used for sealing of the span gas adaptor necessary for field or on-board leak checking (gas comparison) or response time checking equipment. For standardization, it is recommended that the sealing surface be ½ inch in outside diameter and ½ to 1 inch long.

A probe tip cap shall be provided for the sample system check described in Section C.11.

The interconnecting hose shall be of such design and weight that it can easily be handled by the inspector. The hose shall be of non-kinking construction and fabricated of materials that will not be affected by or react with the exhaust gases. Molecular HC hang-up shall be minimized. The hose connection to the analyzer shall be reinforced at the point of maximum bending. The system shall be designed with a water trap in the bypass sample stream. The water trap shall be continually self-draining. The trap bowl shall be constructed of a durable transparent material. The water trap should be located as low as possible on the analyzer so that condensed water in the sample hose will drain into them. However, the trap must be placed in a position readily visible to the operator. The sample for the analyzer shall be obtained from the top of the water trap. The sampling system shall be equipped with a suitable particulate filter upstream of the optical bench. A secondary filter upstream of the sample pump is optional. This filter must have sufficient capacity to filter the samples obtained during the routine testing of vehicles in the inspection station. A prompt shall be provided to the operator indicating when the filter should be changed based on an indication of low flow or other criteria approved by the TACB.

The pumps shall contain corrosion resistant internal surfaces. The pumps shall have a minimum operational life of 2,000 hours with no mechanical or electrical failure.

The pumps may be either a single pump, multiple pumps for the sample and bypass streams, a dual pump for bypass flow and sample flow, or an equivalent system approved by the TACB. The sample pump shall have integral motor overload protection and permanently lubricated, sealed ball bearings. The bypass system shall be connected in the sample system so that any water condensed in the water trap is removed and dumped outside the system. The bypass stream does not pass through the particulate filter.

## **B.6 Storage Temperature**

While in storage, the analyzer and all components thereof shall be undamaged from ambient air temperatures ranging from 20° to 130°F.

## **B.7 Operating Temperature**

The analyzer and all components shall operate without damage and within calibration limits in ambient air temperatures ranging from 41°F to 110°F.

## **B.8 Humidity Conditions**

The analyzer shall be designed for use inside a building or semi-protective shelter that is vented or open to outside ambient humidity. The analyzer, including all components of the analytical, sampling, and computer systems, shall operate within the required performance specifications at ambient conditions of up to 100 percent relative humidity throughout the required temperature range, assuming the components are reasonably protected by the operator from direct contact with rain, fog, or other condensing moisture. Operators shall comply with all special precautions or operating instructions specified by the manufacturer to ensure adequate protection from adverse weather conditions. Manufacturers shall include special instructions to the operator regarding the proper procedures to follow should exposure to a rapid temperature change cause temporary moisture condensation resulting in extended warm-up or other operating problems. Failure of any component due to exposure to temperature and humidity extremes within the limits specified during actual use shall be corrected at the manufacturer's expense unless the malfunction is a result of a failure by the operator to follow manufacturer's operating instructions and precautions. A general recall of analyzers may be considered by the TACB to correct systematic problems or design deficiencies, if necessary.

## **B.9 Temperature Control**

Analyzer components which affect sensitivity and calibration shall have their internal temperature controlled to design temperatures when exposed to the prevailing ambient conditions of any inspection station. These include the conditions noted in the sections titled "Operating Temperature" and "Humidity Conditions" above.

## **B.10 Barometric Pressure Compensation**

Barometric pressure compensation shall be provided. Compensation shall be made for elevations up to 6,000 feet (mean sea level). At any given altitude and temperature, errors due to barometric pressure changes of  $\pm 2$  inches of mercury shall not exceed the accuracy limits specified in this specification. Manufacturers shall describe in writing how compensation will be accomplished. The method used shall be acceptable if approved by the BAR.

# **C. OPERATIONAL DESIGN**

## **C.1 Analytical System**

These analyzers shall utilize nondispersive infrared systems for measuring hydrocarbon (HC), carbon monoxide (CO), and carbon dioxide (CO<sub>2</sub>) emissions [oxygen (O<sub>2</sub>) shall be optional].

## C.2 Readout Display Control Panel

The console shall contain numerical HC (as hexane), CO, and CO<sub>2</sub> (and O<sub>2</sub> if equipped) displays and a pass/fail display.

The numerical display shall be of a digital format. The resolution of the displays shall be as follows:

CO: X.XX%  
HC: XXXX ppm (as hexane)  
CO<sub>2</sub>: XX.X%  
O<sub>2</sub>: XX.X% (if equipped)

The display increments shall be 0.01% CO, 1 ppm HC, and 0.1% CO<sub>2</sub> (and 0.1% O<sub>2</sub> if equipped). The displays shall be capable of maximum readings of 9.99% CO, 2000 ppm HC (as hexane), and 16% CO<sub>2</sub> (and 25.0% O<sub>2</sub> if equipped).

A CRT display shall be provided to indicate pass and fail for HC, CO, or both. An additional indicator light or equivalent CRT display is to be employed for an exhaust leak check. This indication will signal excess dilution in the exhaust system based upon measurement of CO + CO<sub>2</sub> emissions.

The analyzer shall be capable of selecting the pass/fail values (cutpoints) based on vehicle model year, vehicle type, or other criteria for a potential of fifteen vehicle groups. The system shall be designed in such a manner that the standards and vehicle groupings may be readily revised by a service technician. Once entered, cutpoints for each test will be automatically selected by the unit as a result of operator input. The unit shall have the following vehicle cutpoint groups for CO and HC. The remaining groupings will not be used at this time.

The standards are:

Model Year	CO (%)	HC (ppm)
1975-1977	7.50	750
1978	6.50	650
1979	6.00	600
1980	4.00	400
1981 & Newer	1.20	220

The layout of the keyboard, push-button switches, lights, or appropriate display on the panel shall be determined and justified by the contractor, subject to the requirement that the operator may be wearing heavy gloves. Other important human engineering considerations include the visibility of numerical or other appropriate displays.

## C.3 Microcomputer Compatibility

A standard microcomputer must be included in the analyzer and shall be used to control all analyzer functions. This computer shall be a TACB approved unit including all features defined in Appendix A. Each analyzer manufacturer is to develop DOS executable programs for each of the major required functions. These programs shall:

- 1) control each of the analyzer functions and timing;
- 2) examine and obtain values from all of the analyzer sensors;
- 3) read and write information to diskette in standard DOS 1.44 Mb 3.5" format;
- 4) prepare/format new floppy diskettes, and
- 5) archive floppy diskette information between floppy and hard disk as indicated in Section C.6, File Backup.

The TACB reserves the right to add additional programs and functional performance requirements, up to the technical limits of the hardware, to improve the inspection program.

Sufficient flexibility shall be provided in the design of the microcomputer system to allow expansion of the analyzer to include, but not be limited to, the following additional capabilities:

- 1) read bar code labels meeting Society of Automotive Engineers (SAE) specifications;
- 2) transfer data via an IBM PC compatible internal modem and connection to a telephone line;
- 3) connect and recover data from vehicle on-board diagnostic systems meeting SAE specifications when they become available;
- 4) monitor equipment used with loaded mode testing; and
- 5) accommodate NO<sub>x</sub> exhaust monitoring systems.

The manufacturer may offer additional features which utilize the microcomputer as a stand-alone personal computer by providing optional software to perform various non-I/M functions. Read-only access to vehicle inspection information for use in station management, customer service, or other uses may also be provided. Such offerings must not interfere with the inspection requirements, nor in any manner affect or allow the operator to tamper with the inspection-related computer programming or data files.

The analyzer shall be equipped with an internal clock which operates independently from the power source and will provide accurate and automatic date and time information for the following functions:

- a) each test performed;
- b) automatic gas span check (every 3 days); and
- c) automatic leak check (every 3 days).

#### **C.4 Software Loading**

The mechanic shall not have to load the microcomputer's operating or applications software to operate the analyzer. On each POWER ON, the analyzer shall automatically do all microcomputer component self diagnostics and loading of all necessary operating software without mechanic intervention. Upon satisfactory system component check out, the applications software is to present a menu of available analyzer operations. All offered features are to be menu-driven. For each feature, a context sensitive, on-line help facility is to be provided which can be accessed preferably with a single key stroke.

#### **C.5 Data and File Transfer**

All calibration, vehicle test records, and other analyzer files shall be capable of being transferred from the analyzer in two ways:

- 1) The primary method is by removal of the standard 3.5" IBM PS-2 1.44 Mb compatible floppy diskette on which data is stored.
- 2) By means of a standard IBM PC compatible RS232C serial port with baud rate selectable for at least 1200, 2400, or 9600.

The manufacturer must provide all necessary software and protocol for port-oriented file transfers.

The 3.5" floppy drive must be secured logically and physically to permit only duly authorized State and manufacturer access. Methodology to restrict such access shall be approved by the TACB. Manufacturers will be responsible for demonstrating full system compatibility as well as diskette transfer of files to the State. Diskettes must be removable and show full compatibility with existent TACB micro-computers. Port transfer must be MS-DOS 3.3 compatible and show full ASCII file transmission compatibility. Flexibility to modify analyzers to utilize telephone modem systems shall be available should they be required in the future.

All recorded data shall be right justified. Unused fields shall be filled with ASCII blanks, while leading spaces shall be filled with zeros. Decimal points shall not be recorded.

The floppy disk drive shall have the capability to store at least 3000 records not counting those on backup. Data records shall include vehicle test and calibration records as specified in appropriate sections in this specification. Each type of record shall be stored in a separate data file. The data storage space consumed by each record shall be determined by actual record length. Other types of data files may be added in future updates. Storage shall be maintained with power off.

The analyzer shall display the number of remaining records available prior to each test and shall provide a prominent warning message to the operator when space for less than 50 inspections are left.

#### **C.6 File Backup**

At the conclusion of each test or gas calibration, the required data shall be placed in a record file. Three generations of files shall be recorded on disk (TEST.DAT, TEST.BK1, and TEST.BK2) as follows:

- |            |  |
|------------|--|
| TEST. DAT: | This hard disk-based file will contain records onto the hard drive following each test or calibration for which no backup on the floppy disk has been created. Records shall be deleted from the hard drive after creation of TEST.BK2.                |
| TEST.BK1:  | This floppy disk-based file will contain records that have been copied onto the floppy disk, but have not been collected by authorized personnel. Records written to TEST.DAT shall be copied to TEST.BK1 upon completion of each test or calibration. |
| TEST.BK2   | This hard-disk based file shall contain the records collected by authorized personnel. Records must be maintained for at least 45 days after the   |

collection of the diskette by authorized personnel. Procedures must be programmed that periodically purge collected records older than 45 days.

The floppy disk shall contain all the records that have been copied from the TEST.DAT file to the TEST.BK1. The purpose of the TEST.BK2 file is to have a backup to allow the TACB the opportunity to collect data a second time if something was wrong with the disk and it prevents the hard disk from being filled with redundant data. The manufacturer shall provide the State with a method of retrieving data in TEST.BK2 onto an additional floppy disk through the state menu.

### **C.7 Fail-Safe Features**

All I/M related operations of the unit shall remain disabled through a system lockout until the instrument meets the warm-up requirements specified in Section C.21.

A low flow indication and lockout shall be provided which will activate when the sample flow rate is decreased to a point which would not allow the analyzer system to meet the response time specifications indicated in Section C.22.

### **C.8 Data Entry and Storage System**

The analyzer shall be supplied with provisions for data entry and storage.

An alphanumeric keyboard shall be used for data entry and control of the analyzer shall be via the standard microcomputer described in Section C.3. Selection of the test mode shall cause the preset station and analyzer numbers to be entered into the test record as well as the date and time for each test performed and the applicable county code. The following information will then be entered on the keyboard:

1. Inspector I.D.
2. VIN Number
3. Vehicle Make (Table 1)
4. Vehicle Model Year (pre-1975 model years will not be accepted and a prompt shall be presented indicating that an inspection is not required)
5. Vehicle Type (passenger car or truck)
6. Number of Cylinders (2R for rotary or #D for direct ignition systems)
7. Odometer Reading
8. Type of Test (initial, Nth retest, state)  
Note: N = 1-9
9. Repair Costs, if known (for retest & state tests only)
10. Vehicle With/Without Air Injection
11. Single/Dual Exhaust
12. Parameter (anti-tampering) Inspection Results

Note: Underlined inputs may be chosen by default unless changed by the operator in specific cases.

# = number of cylinders

The analyzer shall be designed to require the entry of a special inspector I.D. number before an inspection can begin. The number shall neither be displayed nor printed on the test report but shall be recorded in the vehicle test record. Access to inspector I.D. numbers shall be provided to the operator in order to allow necessary additions or deletions. The TACB intends for the analyzer to have an expandable capacity for storage of inspector I.D. numbers but may be limited to 30 unless the need for further expansion is required in the future. Access to the inspection mode shall not be permitted unless the inspector I.D. number input corresponds to a number stored in the analyzer.



Table 1  
I/M VEHICLE CODES

**Light-Duty Vehicles**

ACUR	Acura	MAZD	Mazda
ALFA	Romeo	MEBZ	Mercedes Benz
AMCO	American Motors	MERC	Mercury
AUDI	Audi	MITS	Mitsubishi
BMW	BMW	NISN	Nissan
BUCK	Buick	OLDS	Oldsmobile
CADI	Cadillac	OPEL	Opel
CHEV	Chevrolet	PLYM	Plymouth
CHRY	Chrysler	PONT	Pontiac
DATS	Datsun	PORS	Porsche
DODG	Dodge	PUGT	Peugeot
FERR	Ferrari	RENA	Renault
FIAT	Fiat	ROVR	Rover
FORD	Ford	SAAB	Saab
GMCO	GMC	STER	Sterling
HOND	Honda	SUBA	Subaru
HYUN	Hyundai	SUZU	Suzuki
INTE	International	TOYO	Toyota
ISUZ	Isuzu	TRIP	Triumph
JAGU	Jaguar	VOLK	Volkswagen
JEEP	Jeep	VOLV	Volvo
LINC	Lincoln	YUGO	Yugo
		OTHR	Other

The analyzer shall be capable of utilizing the Master Reference Table being developed by the BAR. This table will provide emission application and test sequence selection information to help the mechanic perform the inspection/ test more accurately. The Master Reference Table is anticipated to be supplied to the manufacturers by the BAR on a nine track tape in ASCII format. Manufacturers will be required to make a software update to incorporate this table upon completion of TACB review and approval and in accordance with requirements and schedules established by the TACB. Manufacturers will be required to integrate the information from the table into the analyzer software so that test parameters and procedures are properly utilized (in accordance with the specification) during the visual and the emissions tests. Up to five Mbs of total information shall be provided to accommodate the reference table. Changes required on this data will be made during the annual software update. Emergency changes, based on specifications provided by the BAR or TACB and software developed by the manufacturer, shall be made no more often than quarterly. The installation of any emergency changes required after an annual software update during a calendar year shall be the responsibility of the State.

Entry of vehicle and preliminary test information will key appropriate HC and CO limits for a pass/fail decision, appropriate idle speed limits, described in Section C.18, and appropriate anti-dilution limits described in Section C.17. Prior to probe insertion in the vehicle tail pipe, an HC hang-up check shall be performed. The test shall be initiated by using a "start-test" key or equivalent function. Appropriate

prompts and procedures will be required to ensure that all officially approved EPA preconditioning steps, including the restart procedures for vehicles manufactured by Ford Motor Company [40 CFR 85.2201(b)] and the recommended restart of vehicles produced by Honda Motor Car Company, are performed prior to the activation of the test sequence. Updates of analyzer programming and/or hardware shall be performed by authorized service technicians as EPA requirements are revised.

A prompt shall also be provided for all vehicles to increase and hold engine speed at 2500 RPM  $\pm$  300 RPM for a consecutive 30 seconds in order to ensure proper warm-up of vehicles. Continuation of the test sequence shall be prevented until this high idle warm-up is completed.

After the probe has been inserted into the tail pipe, the emission test will be conducted automatically with no further operator action, i.e., the sample will be validated (dilution check), readings will be taken, values will be compared to limits, and a pass/fail determination will be made (See Section C.16.). Emission readings shall not be displayed until after completion of the test.

The following test/sampling sequence shall be available in the software at the time of certification:

Sequence #1: Testing period: 30 seconds

Basis for test results: Average of last 5 seconds of each period.

Test Sequence #1 shall be used to test all vehicles except those required to follow approved preconditioning procedures to satisfy federal warranty conditions.

Accommodations shall be made to allow for additional test sequences and sampling periods, which can be added at a later date. The analyzer should be designed to automatically run the appropriate test sequence after vehicle identification information is entered. Test sequence numbers are expected to be incorporated into the Master Reference Table.

For vehicles with dual exhaust, the analyzer manufacturer may provide a dual probe measurement system. Alternatively, manufacturers may utilize an averaging algorithm which requires the operator to run two emission tests. If the averaging method is used, prompts shall be displayed telling the operator when to switch the probe to the other tail pipe and when a second preconditioning of the engine is necessary between tests.

If the vehicle passes or qualifies for a punched certificate, an appropriate certificate number will be entered manually. If the vehicle passes all emission-related inspection requirements but fails a safety inspection requirement, the term "failsafe" shall be entered by the operator in place of a certificate number. Model year will key appropriate inspection fee. In accordance with DPS regulations, the first retest (1R), if offered within 15 days on the initial test, shall be free. Additional retests (2R-9R) shall be charged.

When repairs are performed on a vehicle at the inspection station to correct an initial parameter inspection failure but before the initial idle inspection test is started, an "R" shall be input in place of a "P/F/N." This shall signify that adequate repairs have been performed to correct the detected tampering. The prompt for estimated repair cost normally required in a retest sequence shall be provided if the "R" code is used, in an initial test sequence.

The HC and CO readings, a pass/fail determination, and other appropriate information will then be supplied to the printer and properly recorded by the computer in accordance with the format in Table 2.



Table 2

## I/M VEHICLE TEST RECORD

General Information		Method	Bytes
1. County Identification (alpha two-letter code provided by TACB)		A	2
2. Station Number (alphanumeric)		A	5
3. Analyzer Number (alphanumeric single letter designation followed by last three numbers of unique serial number)		A	4
4. Date (YY/MM/DD)		A	6
5. Time (24-hour clock)		A	4
6. Test Sequence Number		A	3
Inspection Information			
7. Inspector Number (numeric)		M	8
8. VIN Number (alphanumeric)		M	20
9. Vehicle Make (alpha)		M	4
10. Vehicle Model Year (numeric)		M	2
11. Vehicle Type - Passenger Car/Truck (C/T)		M	1
12. Number of Cylinders (alphanumeric)		M	2
13. Odometer Reading (numeric)		M	6
14. Test Type - Initial/Retest/State (I/1R-9R/S)		M	2
15. Repair Costs XXXX/Unknown (UNKN)		M	4
Parameter Inspection Results			
16. Misfire (P/F/N/R)		M	1
17. Lead Test (P/F/N/R)		M	1
18. Catalyst (P/F/N/R)		M	1
19. Fuel Inlet (P/F/N/R)	M	1	
20. Evap. Control (P/F/N/R)		M	1
21. AIR System (P/F/N/R)		M	1
22. Oxygen Sensor (P/F/N/R)		M	1
23. Choke System (P/F/N/R)		M	1
24. PCV System (P/F/N/R)		M	1
25. EGR System (P/F/N/R)		M	1
26. TAC System (P/F/N/R)		M	1
Idle Emissions Test Results		Method	Bytes
27. CO Emission Test XXXX		A	4
28. HC Emission Test XXXX		A	4
29. CO + CO <sub>2</sub> Test XXXX		A	4

30. CO Emission Test (P/F)	A	1
31. HC Emission Test (P/F)	A	1

### **Final Inputs**

32. Dilution (V/I)	A	1
33. RPM (V/I/N)	A	1
34. Overall Inspection Results (P/F/I)	A	1
35. Certificate Number (alphanumeric)	M	8
36. Software Version Number	A	4
37. Software Update Field	A	4

Total Bytes 117

NOTE: Method designates Automatic/Manual Input (A/M).

Analyzers shall be capable of allowing the operator to change the inspection station number upon relocation of the analyzer to another station without allowing access to other program features or data records. This feature is intended to provide for the limited transfer of analyzers between stations as authorized by the DPS for use as backups.

Upon delivery of the system to the purchaser, the manufacturer is to include four (4) new 3.5 inch floppy diskettes stored in individual protective containers. The State of Texas will be responsible for collecting the diskettes from the licensed facilities each quarter. If a diskette must be removed by a service representative, the diskette shall be returned to the DPS within five business days or shall be left with the inspection station operator in a clearly marked sealed envelope until the next scheduled visit by the DPS. Only authorized state personnel and service representative shall be permitted to change diskettes. This capability shall be provided through the secured physical access and the use of limited access codes.

### **C.9 Printing System**

The system shall have a printer which will provide at least two copies, one for the motorist and one for the licensed facility, of a legible printout. While this inspection report may include additional information or be pre-sented in alternative formats, the following minimum information must be clearly presented:

999 Texas Vehicle Inspection - County (complete spelling)

Inspection Station Number	XXXXXX
Analyzer Number	XXXX
Date	XX/XX/XX (MM/DD/YY)
Time	XX:XX (am/pm) (12-hour clock)
VIN Number	XXXXXXXXXXXXXX
Vehicle Make	XXXX
Model Year	XX
Type of Vehicle	Passenger Car/Truck
Number of Cylinders	XX (2R for rotary or #D for direct ignition systems)
Odometer Reading	XXXXXX

Type of Test	Initial/Nth Retest/State
Repair Costs, if known	\$XXXX/Unknown

#### Parameter Report

Misfire	Pass/Fail/Not Applicable/Repaired
Lead Test	Pass/Fail/Not Applicable/Repaired
Catalyst	Pass/Fail/Not Applicable/Repaired
Fuel Inlet	
Restrictor	Pass/Fail/Not Applicable/Repaired
Evaporative	
Control System	Pass/Fail/Not Applicable/Repaired
Air Injection	
System	Pass/Fail/Not Applicable/Repaired
Oxygen Sensor	Pass/Fail/Not Applicable/Repaired
Choke System	Pass/Fail/Not Applicable/Repaired
PCV System	Pass/Fail/Not Applicable/Repaired
EGR System	Pass/Fail/Not Applicable/Repaired
Thermostatic	
Air Cleaner	Pass/Fail/Not Applicable/Repaired

#### 2 Emission Test

	Standard	Test	Report
CO (%)	XX.XX	XX.XX	Pass/Fail
HC (ppm)	XXXX	XXXX	Pass/Fail
Dilution			
(CO + CO <sub>2</sub> ) (%)	XX.X	XX.X	Valid/Invalid
RPM	XXXX	XXXX	Valid/Invalid/No RPM

Test Results	1. Valid/Invalid Test (RPM or Dilution)
	2. CO Pass/Fail
	3. HC Pass/Fail

#### General Inspection Information

Overall Inspection Results	Pass/Fail/Invalid
Inspection Fee	\$XX.XX
Certificate Number	XXXXXXXXXX/None

This inspection was properly performed and meets 207(b) warranty requirements (40 CFR 85, Subpart W).

\_\_\_\_\_  
Certified Inspector's Signature

NOTE: X's denote entries to be filled with alphanumeric characters.

If a vehicle is less than five years old, as referenced to the real time clock, has less than 50,000 miles on the odometer, and fails the tail pipe emissions test, then the inspection report printout shall include the following message or its equivalent: "YOUR VEHICLE MAY BE ELIGIBLE FOR WARRANTY REPAIRS, SEE YOUR OWNER'S MANUAL OR CONTACT YOUR LOCAL DEALERSHIP FOR MORE INFORMATION."

### C.10 Automatic Gas Calibration

The analyzer shall be designed to require an automatic single point gas calibration for HC, CO, and CO<sub>2</sub> (and for O<sub>2</sub> if equipped) and an automatic electrical zero and span check. The automatic gas calibration shall be conducted after a new diskette is inserted and at a frequency of at least every 3 days, activated by the internal clock. The calibration information shall be recorded in accordance with the format in Table 3. Electrical zero and span check (automatic) shall be required prior to each test sequence. User friendly prompts shall be provided to the operator to indicate every step needed to properly perform the required gas calibration (including when it is necessary to turn the gas cylinder valve on and off).

Table 3

#### I\M GAS CALIBRATION RECORD

Automatic Input		Bytes
1. Gas Cal Indicator		1
2. Station Number (alphanumeric)		5
3. Analyzer Number (alphanumeric - see Table 1)		4
4. Date (YY/MM/DD)		6
5. Time (24-hour clock)		4
6. PEF (C3/C6 Factor)	XXX	3
<b>Manual Input</b>		
7. CO Span Gas (%)	XXXX	4
8. HC Span Gas (Propane ppm)	XXXX	4
9. CO <sub>2</sub> Span Gas (%)	XXX	3
10. O <sub>2</sub> Span Gas (%)	XXXX	4
	(if equipped)	
<b>Analyzer Inputs</b>		
11. CO Zero		5(1)
12. HC Zero		5(1)
13. CO <sub>2</sub> Zero		4(1)
14. O <sub>2</sub> Zero (if equipped)		5(1)
15. CO Span Reading		4
16. HC Span Reading		4
17. CO <sub>2</sub> Span Reading		3
18. O <sub>2</sub> Span Reading (if equipped)		4

NOTE: (1)Negative readings shall be preceded by a "minus."

If the system is not calibrated or the system fails the calibration or the zero and span check, an error message or fault indication shall be displayed and the analyzer will be locked out to prevent the performance of the next sequential function until the system is properly calibrated and passes such calibration and zero span check.

The gas calibration shall ensure that accuracy specifications are satisfied and that linearity is correct at the required span point. The gas calibration procedure shall correct the readings to the center of the allowable tolerance range. The gas calibration and leak check procedures shall require no more than 5 minutes. The analyzer shall provide adequate prompts on the display to guide the mechanic through the calibration procedure in a manner that mini-mizes the amount of gas used.

For HC, CO, and CO<sub>2</sub>, analyzer manufacturers shall limit gas usage during the gas calibration procedure to two liters per span point or demonstrate to the satisfaction of the TACB that a greater amount must be utilized to properly calibrate their instrument and that it would be cost prohibitive to reduce it to acceptable levels. The analyzer shall also be designed to keep the loss of calibration gas to a absolute minimum (less than 0.5 liters in 24 hours) if the mechanic forgets to shut the valve off. Manufacturers shall include an evaluation of this capability, consisting of at least 5 analyzers, with their certification application materials and shall demonstrate this feature during certification.

The analyzer shall be equipped with a gas calibration port for the purpose of performing a probe to calibration port comparison. Gas calibrations shall be accomplished by introducing standard gases into the analyzer either through the calibration port or through the probe. Span gases utilized for calibration shall be within two percent of the following span points:

600 ppm propane  
1.6 % carbon monoxide  
11.0 % carbon dioxide  
20.9 % oxygen (if equipped)

Ambient air may be used to  
calibrate the oxygen sensor.

The standard gases used to span, calibrate, and audit the analyzers shall satisfy the criteria included in the Federal Clean Air Act, Section 207(b) and described in Subpart W of Part 85 of Chapter I, Title 40 of the Code of Federal Regulations. In order to ensure that the quality of the standard gases used in the program meet these specifications, all standard gases purchased by the owner or operator of a participating inspection station for use in the analyzer must conform to the requirements established in 1984 by the California BAR for Test Analyzer System Calibration Gases (October 16, 1984). These requirements include the testing and certification of the concentration, accuracy, precision, and purity of the standard gases to within the referenced limits and the labeling of individual gas canisters describing these and other specified parameters.



Alternate gas calibration systems, used in lieu of introducing gas at the specified span points, or proposals for less frequent gas calibrations will be acceptable if approved by the BAR.

### **C.11 Automatic Leak Check**

An automatic leak checking system shall be provided that will allow the vacuum side of the system to be checked for leakage. Appropriate valves, lines, and switches shall be installed to permit this operation. Minimal activity by the operator, such as setting the probe in a holder or capping the probe, is permitted, provided errors resulting from improper operator action would be identified by the computer and would require corrective action or improper operator action would tend to cause the system to fail a leak check. User friendly prompts shall be provided to the operator to indicate every step needed to properly perform the required leak check (including when it is necessary to turn the gas cylinder valve on and off).

A system leak check shall be accomplished in conjunction with the gas calibration performed every 3 days, activated by the internal clock, and following each diskette change. The analyzer shall not allow an error of more than approximately 3% for each calibration gas or 18 ppm HC on 600 ppm HC (hexane) span gas, 0.05% CO on 1.6% CO span gas, and 0.33% CO<sub>2</sub> on 11.0% CO<sub>2</sub> span gas when the leak check is performed. The leak check shall include a check of the sample hose and probe. Fittings and connectors used on the sample hose and probe shall be constructed to prevent the bypass of the leak check. Two liters of calibration gas may be used to perform the leak check. If the system is not leak checked, or the system fails a leak check, an error message or fault indication shall be displayed, and the analyzer will be locked out to prevent the performance of the next sequential function until the system is properly leak checked and passes such leak check.

### **C.12 Automatic Hang-Up Check**

The analyzer shall be designed for automatic HC hang-up check of the sampling system using room air. The analyzer shall have a selector switch or button with indicator light labeled "Hang-up Check," or other equivalent CRT prompter/indicator. "Hang-up" activation shall cause the analyzer to automatically sample room air through the sample line and probe. The check system shall continue to sample room air for a maximum of 300 seconds or until the HC response is below 20 ppm hexane.

If the HC hang-up does not drop below 20 ppm within 150 seconds, a message shall be displayed indicating possible dirty filters or sample line. If after 300 seconds HC levels are not below specified value, the test shall be discontinued until HC hang-up is corrected. When the level stabilizes below this value, an indication that testing may begin shall be displayed. The analyzer shall be precluded from operating until the HC level is met.

### **C.13 Vehicle Diagnosis**

For the purpose of vehicle diagnosis and/or repairs, the analyzer shall have a selector switch, or button, or other equivalent CRT indicator labeled "Vehicle Diagnosis" or "Vehicle Repair." Activation of "Vehicle Diagnosis" shall allow the analyzer to continuously monitor the vehicle exhaust regardless of inspection status (e.g., system needs weekly span check, leak check, warm-up condition, etc.). An analyzer which is in "Vehicle Diagnosis" status shall not activate the idle speed lockout function described in Section C.18 of this specification.

The automatic data collection system shall be prevented from operating anytime the analysis system is in a "Vehicle Diagnosis" status. Any time the printer is used while a vehicle is in the diagnosis mode, the words "this is not an emission inspection report" or some suitable message acceptable to the TACB shall be clearly printed. Auxiliary analog trend meters may be used providing that they are deactivated for inspections.

#### **C.14 Tampering Resistance**

Controlled access design shall be the responsibility of the manufacturer and is subject to approval of the TACB. Analyzer operators shall be prohibited from creating or changing any I/M-related test results, programs, or data files contained in the analyzer. Manufacturers shall utilize special Basic Input/Output System (BIOS) partitions (or equivalent approved by the TACB), as well as other appropriate software and hardware provisions, necessary to protect the I/M files and programs. File and program protection may consist of mechanical systems in combination with electronic/software systems. The protection features shall prevent access to the secured floppy disk drive and portions of the hard disk containing I/M programs and test data. The "control" key or its functional equivalent giving access to DOS shall not be activated except through the use of a special password and a "blind" entry on the state and service accessed menu. The password shall be chosen by the TACB at the time of certification testing. Other security or protection alternatives, including more sophisticated BIOS limitations, may be proposed by the analyzer manufacturer for approval by the TACB.

In addition, the emission analyzer and sampling system shall be made tamper-resistant. At a minimum, the manufacturer shall develop tamper-resistant features to prevent unauthorized access through the cabinet. Microswitches, keyed locks, software algorithms requiring the use of a password which would be changed on a quarterly basis by the manufacturer, etc., would all be acceptable provided the physical or logical design effectively prevents unauthorized access. For example, a mercury switch would not be effective if the analyzer can be tipped over to one side to trigger the switch. A keyed lock would not be effective if it is placed in a position that allows the analyzer cabinet to be flexed slightly to bypass the lock. Manufacturers may offer analyzers with additional floppy disk drives that can run optional software application programs. However, the optional floppy disk drives shall be secured behind a compartment door equipped with a microswitch (or equivalent) which prevents the recording or printing of inspection records whenever the door is open or the drive is in use. Read-only access to inspection records on the secured floppy disk drive may be allowed.

If tampering occurs, a software lockout algorithm shall be activated which aborts any existing test sequence and prevents further I/M testing until the lockout is cleared by an authorized service representative or DPS trooper.

The lockout system shall be designed so that it can be activated by the DPS from the state access menu. Only a DPS trooper, or other representative with specific written authorization from the DPS, may remove lockouts put in place from the state access menu. Manufacturers shall develop a system by which their service technicians shall be prevented from clearing DPS installed lockouts.

It is the intention of the TACB to allow the analyzers to be used with systems being developed by the SAE committee which is attempting to develop standardized specifications for a general vehicle diagnostic link. The tamper resistance features shall be designed so that these and other available software programs, especially those which deal with repair and diagnostics of vehicles, can be added at a later date.

Optional software packages supplied by the manufacturer shall not interfere with the normal operation of the I/M inspection and testing software, shall not compromise the tamper-resistant features of the analyzer, and shall be reviewed by the TACB before they are delivered or installed in any analyzer.

### **C.15 Automatic Test Sequence**

The analyzer systems must be capable of being programmed to provide a variety of automatic features relating to operator input, prompting on CRT, determination of emissions categories, and testing sequences based on keyboard entries and data output into paper copy and data storage. The system shall perform the functions of accepting, displaying, and reporting all necessary data from the various input sources. The system shall also be capable of making pass/ fail decisions and of initiating automatic zero and gas spanning, leak checking, and HC hang-up procedures. Please note that exiting data for whatever reason will not be permitted for the CO, HC, and CO<sub>2</sub> tests. In other words, the inspector shall not erase and restart the emission test. Accordingly, no emissions pretest will be allowed.

The analyzer shall have, as a minimum, the capability to recall and display any of the previous 25 vehicle test records for retest. Recall shall be initiated by typing in the VIN number or by cursor selection from the list of available vehicles. The operator shall have the ability to transfer only the vehicle identification information (VIN number, make, model year, type, number of cylinders, air injection, and dual/single exhaust) on the test records recalled so that it can be used for subsequent tests. The mechanic shall be required to reenter the odometer and test type for subsequent tests. The analyzer shall be capable of displaying the previous test and inspection results, but shall not be capable of allowing them to be changed.

#### **Inspection Prompt Sequence**

The following sequence shall be utilized:

1. Warm-up and self-calibration procedure
2. Inspector I.D.?
3. VIN Number?
4. Vehicle Make?
5. Vehicle Model Year?
6. Vehicle Type?
  - a. C for Passenger Car
  - b. T for Light-Duty Truck
7. Number of Cylinders?
8. Odometer Reading?
9. Type of Test?
  - a. Initial
  - b. Retest Number (If 1R, input date of initial inspection)
  - c. State (Not displayed on standard menu, state access only).
10. Estimated Repair cost, if known (only on Retest & State tests)
11. Air Injection? (Presence of air injection system may also be determined by response to parameter inspection list)
12. Single or Dual Exhaust?
13. Parameter Inspection List (P/F/N/R)

14. Based on the presence of an air pump and the number of cylinders, CO + CO<sub>2</sub> level, and RPM limit are automatically set.
15. Display cutpoints and actual levels:
  - a. CO %
  - b. HC ppm
  - c. CO + CO<sub>2</sub> %
  - d. O<sub>2</sub> % (if equipped)
16. Emission Test (Valid/Invalid)
17. Emission Test (Pass/Fail)
18. The inspection fee is determined from Table 4 based on the model year of the vehicle inspected.  
(If date of IR is less than 15 days after initial test, no inspection fee shall be assessed.)
19. Certificate Number (if pass/temporary waiver granted)

Table 4

I/M INSPECTION FEES

Vehicle Model Year	Inspection Fee
1975 - 1979	\$13.50
1980 & newer	\$16.25

NOTE: Inspection fees are subject to change by the Texas Public Safety Commission. Updates to these fees shall be made within 30 days after notification by the DPS or TACB.

**C.16 Dilution**

The analyzer manufacturer shall document to the satisfaction of the TACB that the flow rate on the analyzer shall not cause more than 10% dilution during sampling of the exhaust at normal idle (10% dilution is defined as a sample of 90% exhaust and 10% ambient air). Manufacturers shall utilize the procedures specified by the BAR for demonstrating this dilution criteria.

The analyzer shall be equipped with a feature to identify vehicle exhaust system leaks and sample dilution. The preferred technique for identifying leaks is monitoring the CO + CO<sub>2</sub> levels in the exhaust. Other additional techniques that can demonstrate improved sensitivity to leaks may also be used. At least two lower-limit CO + CO<sub>2</sub> values and one spare channel shall be capable of being used:

Vehicle equipped with air injection: 4%  
 Vehicle without air injection: 6%  
 Spare channel

The microcomputer will prevent testing if the CO + CO<sub>2</sub> value is outside of the specified limits. Dilution thresholds may also be contained in the Master Reference Table. The test parameters shall be based on the least restrictive of the two standards. If the CO + CO<sub>2</sub> reading is less than the lower limit, the inspector shall be prompted to check the exhaust system for leaks and to make sure that the sample probe is all the way into the tail pipe. If the excessive dilution is detected after the initiation of the test sequence, the analyzer output shall display, print, and store "Invalid Test" indication.

**C.17 Engine Tachometer/Excessive Idle Lockout**

A digital tachometer shall be integrated with the console for the purposes of measuring engine speed according to the number of cylinders indicated in the data entry section. The hookup to the engine shall be by means of a pick-up capable of detecting RPM with a 0.5 second response time and an accuracy of + 3.0% of the true RPM. The operator shall be prompted to shut the engine off while connecting the RPM probe. Reasonable efforts shall be made to assist the inspector in locating an RPM signal. Based on the vehicle identification information available to the inspector, the analyzer may prompt the inspector regarding which vehicles require a primary pick-up, which require that an alternate counting algorithm be used, and which require the use of an auxiliary piece of equipment. Analyzers shall be provided with all the software and hardware that is necessary to make them capable of reading engine

speed on all affected vehicle models manufactured as of the year of analyzer certification or as specified in subsequent updates.

### **Idle Speed Range**

More than 4 cylinders 300 - 1,200 RPM

4 or less cylinders 300 - 1,600 RPM

The microcomputer will prevent testing in the inspection mode if the engine speed signal is outside the RPM limits. The inspector shall be prompted to set the idle speed to the manufacturer's specifications before continuing the test. If the test idle speed range is exceeded or if the speed fluctuates in excess of 20% of the reading after the initiation of the test sequence, an "Invalid Test" to occur and to be displayed, printed, and stored.

For 1990 and newer model year vehicles only, a "no RPM" by-pass test mode shall be provided to enable the operator to complete a valid test when engine ignition design makes the hookup to the analyzer impractical. This option shall not be automatic and a prompt shall be provided requiring the operator to confirm this choice prior to proceeding with the test. Appropriate idle speed and stability will be judged by the operator in such cases.

### **C.18 Overall Accuracy**

Each analyzer shall have an overall accuracy which limits the maximum error to  $\pm 3\%$  of each range or portion thereof as follows:

HC: 0 to 400 ppm HC =  $\pm 12$  ppm  
400 to 1000 ppm HC =  $\pm 30$  ppm  
1000 to 2000 ppm HC =  $\pm 60$  ppm

CO: 0 to 2% =  $\pm 0.06\%$   
2 to 5% CO =  $\pm 0.15\%$   
5 to 10% CO =  $\pm 0.3\%$

CO<sub>2</sub>: 0 to 10% CO<sub>2</sub> =  $\pm 0.3\%$  CO<sub>2</sub>  
10 to 16% CO<sub>2</sub> =  $\pm 0.5\%$  CO<sub>2</sub>

O<sub>2</sub>: 0 to 10% O<sub>2</sub> =  $\pm 0.5\%$  O<sub>2</sub>  
10 to 25% O<sub>2</sub> =  $\pm 1.3\%$  O<sub>2</sub>

### **C.19 Drift**

If zero and/or span drift cause the infrared signal levels to move beyond the adjustment range of the analyzer, the operator shall be locked out from testing and instructed to call for service. The analyzer manufacturer shall indicate, in writing, at what point the drift lockout will occur.

## C.20 Warm-Up

The analyzer shall reach stabilized operation in a garage environment within 15 minutes at 41 ° F from power on. The instrument shall be considered "warmed-up" when the zero and span readings for HC, CO, and CO<sub>2</sub> have stabilized, within 3% of the full range of low scale, for five minutes without adjustment. A lockout feature shall prevent the performance of I/M testing until zero drift is stabilized. While the analyzer shall continue to try to achieve the warm-up requirements, an error message shall be displayed if stabilization does not occur within 20 minutes and the operator shall be prompted to call for service.

## C.21 Response

The response time from the probe to the display shall not exceed eight seconds to 90% of a step change in input. If an analyzer is equipped with an optional O<sub>2</sub> sensor, the response time shall be no more than 15 seconds to 90% of full scale.

## C.22 Optical Correction Factors

The hexane/propane equivalency factor (PEF) shall be limited to values between 0.49 and 0.54. The BAR-90 specification for optical correction factor may be substituted at the manufacturer's discretion. Factor confirmation shall be made on each analyzer assembly by measuring both N-hexane and propane on assembly line quality checks. The PEF shall be permanently attached to the cabinet containing the optical bench so that if the bench is replaced, the PEF number will be removed with it and the new bench will show the PEF it was designed to use. Changing the optical bench shall not require the service technician to make a new tag, but shall require the technician to change the PEF number in the analyzer software.

The beam strength from the source to the detector for all channels shall be monitored such that when the beam degrades beyond the adjustment range of the analyzer, the analyzer shall be locked out from operation. The manufacturer shall specify at what point degradation occurs whereby the signal cannot be corrected.

## C.23 Interference

The effect of extraneous gas interference on the HC, CO, and CO<sub>2</sub> analyzers shall not exceed  $\pm 10$  ppm HC,  $\pm 0.05\%$  CO, and  $\pm 0.20\%$  for CO<sub>2</sub>.

Electromagnetic signals found in an automotive environment shall not cause malfunctions or changes in accuracy in the electronics of the analyzer. The instrument design shall insure that readings do not vary as a result of electromagnetic radiation and induction devices normally found in the garage environment (including high energy vehicle ignition systems, RF transmission radiation sources, and building electrical systems. In addition, the manufacturer shall ensure that the analyzer processor and memory components are sufficiently protected to prevent the loss of programs and test records.

## **APPENDIX A - MICROCOMPUTER SPECIFICATIONS GENERAL REQUIREMENTS**

### **Acceptance**

All equipment and software submitted for certification must be the full and current configuration proposed for sale. PARTIAL, DATED, OR INCOMPLETE MODELS ARE NOT ACCEPTABLE.

Acceptance of the microcomputer portion of the analyzer will be dependent upon the satisfactory performance of the full proposed configuration meeting all the requirements of this specification.

The proposed hardware configuration must be fully supported by all software and/or operating systems listed in the acceptance requirements or elsewhere in these specifications. Performance tests to prove compatibility will be required. This test will be conducted at the Texas Air Control Board (TACB) offices in Austin, Texas. The vendor will bear all shipping and installation charges for such testing.



## **MINIMUM REQUIRED CONFIGURATION**

### **Operating System:**

Each unit must be supplied with Microsoft DOS version 3.3 (or more current version).

### **Processor:**

The microprocessor must be fully compatible with either the Intel 80286 or 80386 microprocessors. The system must operate with a Norton performance index of at least 4.0.

### **RAM Memory:**

The system must contain at least 1 MB of user available RAM.

### **BIOS:**

The system must include a ROM BIOS (Basic Input/Output System) which provides a self-diagnostic routine to check out the performance of critical PC components (including, at a minimum, the processor, firmware ROM, hard disk, keyboard, clock, setup RAM and memory) upon power up and which enables full use of MS-DOS 3.3. This BIOS must fully support all supplied components (except secured floppy) and all normally supported IBM PC-AT and MCA (or an alternative approved by the TACB) components.

### **Video:**

The display must be at least 12" in diagonal measure and may be either color or monochrome. Regardless, the display must be driven by a color graphics interface fully compatible with the IBM VGA color graphics adapter. This interface must be able to run in the IBM EGA, CGA, and monochrome modes.

The software shall automatically blank the screen if no keyboard entry is made for 30 minutes. The display shall return when the operator strikes any key. Alternative proposals to protect the monitor may be proposed to the TACB for evaluation.

### **Floppy Disk:**

Each unit must be equipped with one standard 1.44 Mb 3.5 inch IBM compatible floppy disk drive, accessible only to DPS authorized personnel. The unit shall be capable of reading, writing, and formatting the high density 3.5 inch diskettes for use in existing TACB microcomputers directly without need for any conversion. The manufacturer shall identify at the time of certification any brands of floppy disks which are recommended for use in the analyzer. The secured floppy drive shall be designated the "A" drive.

A second floppy drive must be available as an option to allow the inspection station to utilize other software programs. However, the system design must satisfy all of the tamper-resistant features in Section C.14 for protection of the secured floppy disk drive and the portions of the hard disk containing I/M programs and files. This second floppy drive shall be designated the "B" drive.

#### Hard Disk:

Each unit must come with at least 40 Mbs of usable hard disk storage. The manufacturer may use up to 10 Mbs for their proprietary programs and data, leaving at least 30 Mbs of usable storage is available for TACB. The manufacturer may utilize portions of the 30 Mb partition of the hard disk for optional programs with the understanding that TACB required programs shall take precedence should data storage become limited. The hard disk is to be self parking and able to operate reliably in the expected hostile garage environment. That hard drive must also include a TACB approved method to limit logical access to data and programs. The hard disk containing the I/M programs and files shall be designated the "C" drive.

#### I/O Ports:

The unit must include at least one MS-DOS/IBM PC standard compatible parallel printer port and one baud rate programmable (300 to 19.2K) IBM PC compatible serial port with a male DB-25 (25 pin) connector. The parallel port may be connected to the printer, but the serial port must be available. All ports must be clearly labeled and easily accessible. However, access must be restricted to State authorized representatives only.

#### Keyboard:

The TAS keyboard must be fully interfaced with the microcomputer and have all of the necessary normal, numeric, cursor, control, shift, alternate, and function keys needed to operate a standard IBM PC-AT compatible microcomputer, preferably a full 101 keys should be provided.

#### Expansion:

Ample standard PC-AT expansion slots must be available to accommodate enough additional full sized PC-AT type expansion boards necessary to allow the addition of all capabilities specified in Section C.2. Likewise, the configuration must be able to accommodate at least one additional standard one-half height hard disk drive.

#### Printer:

The analyzer is to use an impact printer, or equivalent, to print inspection reports. The printer shall be equipped with at least a nine pin print head and be capable of printing in either draft (9 X 9 dot matrix) or in near-letter-quality mode (18 X 18 dot matrix) selectable by the operator. The printer shall be capable of printing in either Pica (10 character per inch) or Elite (12 character per inch). The printer shall be capable of printing 120 characters per second in draft-Pica pitch. Continuous (8.5" x 11" finished) fan-fold, pin fed paper is to be used.

There shall be unlimited access to the test report printer so that paper can be easily replaced, printer jams can be cleared and ribbons can be replaced.

Printers must be able to copy graphics output from CRT displays and to print the full IBM standard PC character set, standard IBM VGA compatible graphics, and bar codes compatible with the AIAG B-1 and B-2 standards. Printers are to be hardware and software compatible with the IBM PC.

A standard IBM/Centronics interface with parallel cable is to be used. Likewise, printers shall fully conform to the setup, codes, and operation of one of the major printers.

Printers must be designed for the garage environment and must not be susceptible to overheat or other extended usage related problems. The printer shall be capable of printing continuously for at least 25 full pages of text without stopping due to overheating. The printer shall have an automatic thermal shutoff feature or the analyzer software shall display a message to the operator when and only when more than the recommended number of pages are to be printed all at once.

### **Acceptance Test**

A demonstration test will be required prior to certification to assure that all items offered meet the specified requirements.

This test, will be conducted at the TACB office in Austin, Texas. The vendor is required to provide and set up the entire configuration proposed in his response to this specification. Lists of the users standard hardware and software are attached.

### **Compatibility**

Computers offered must be able to reliably read and write floppy disks for use with existing IBM PS-2 1.44 Mb 3.5" diskettes using 3.3 and later versions of IBM PC-DOS operating systems.

Systems must be able to interchange/use software and data files with existing State-owned IBM PC, IBM PC-XT, IBM PC-AT, and IBM PS-2 models without requiring software or hardware reconfiguration.

Systems must be capable of producing graphic output on CRT displays and dot matrix printers. Graphics requirements include (but are not limited to) the ability to display graphic output from applications like Lotus 1-2-3, Gem, Decision Resources, and applications developed by the users written in MS QUICK BASIC, MS BASIC, and/or GWBASIC. Use of 'PrtSc' key must cause text displayed on CRT to print on printer. The graphics interface must fully support MS BASIC as is normally provided with PC-DOS.

## **DOCUMENTATION**

(To be provided to the TACB only)

### **HARDWARE**

For the microcomputer portion of each system delivered, the vendor must provide complete technical/operational manuals covering installation and operation.

### **SOFTWARE**

All prepackaged applications software deliveries (including but not limited to Operating Systems and BASIC if offered) must include manuals that fully explain all installation and operating procedures.

All such software deliveries must include warranty, a licensing agreement, and (except for operating systems) a means for registration that provides for future updates.

All software deliveries must include the version or release number.

All software deliveries must include a list of the computers the software is guaranteed to run on.

## **MANUALS**

All manuals must be commercially-printed and must show title, manufacturer's name and address, and copyright date.

## **FILES**

All MS-DOS file must include a full record layout. This layout must identify file name, security, and each field. For each field the delimiters, contents, definition, and editing rules are to be provided in the form of a data dictionary.

## **STANDARD HARDWARE**

During an acceptance test to prove compatibility, the proposed computer will be tested for compatibility with either the IBM MCA or IBM AT type systems. MCA compatible units will be tested for configuration and software. AT compatible units will be required to have the expansion capability to function with items in the following list. Modification to the proposed computer will not be allowed, except for changing of dip switches as needed to identify memory installed, or to identify I/O ports, etc.

### **Display Adapters and Monitors**

Everex VGA, Paradise VGA and Video-7 Vega VGA with NEC Multisync Plus

### **Expansion Cards**

INTEL Above Board with minimum memory and maximum memory

### **Hard Disk Expansion**

System must include a hard disk interface which will fully support a second internal disk drive of the same type as the original type drive or a functional equivalent approved by the TACB which does not compromise tamper resistance.

### **Tape Backup**

Mountain Tape Back-up and Irwin Tape Back-up

### **Additional Storage**

3.5" 1.44 Mb Floppy Disk Drive  
10 Meg 10 x 10 Bernoulli Box (Boot and non-boot)  
10 Meg 20 x 20 Bernoulli Box (Boot and non-boot)  
IBM Optical disk drive

## **MOUSE**

Microsoft Serial Mouse and Microsoft Bus Mouse

## **COMMUNICATIONS**

Hayes internal Modem 2400B  
Multi-tech External Modem 2400

## **MICROCOMPUTER COMPATIBILITY SPECIFICATIONS GENERAL REQUIREMENTS**

### **Standard Software**

During an acceptance test to prove compatibility, the proposed computer will be required to run the latest release of software selected from the following list. The proposed system may also be required to run user programs using earlier releases of software listed.

Modification to the proposed computer will not be allowed.

Modification to the standard software packages beyond normal installation procedures will not be allowed.

### **SPREADSHEET**

Lotus Development Corp	- Lotus 1-2-3 Rel 2&2.2
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### **WORD PROCESSING**

WordPerfect Corporation	- WordPerfect
MicroSoft	- Word

### **DATA BASE MANAGERS**

Ashton-Tate	- dBase III Plus
Borland	- Reflex
Ansa Software	- Paradox

### **GRAPHICS**

Digital Research	- Gem Draw
	- Gem Graph
	- Gem Collection
Intl. Microcomputer Software, Inc.	- PC Paintbrush

### **OPERATING SYSTEMS**

Microsoft	- MS DOS 3.3 or later
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### **UTILITIES**

Peter Norton	- Advanced Norton Utilities
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### **COMMUNICATIONS**

Microstuf	- <u>Zmodem</u>
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### **USER SOFTWARE**

Microsoft	- MS BASIC & Programs QUICK BASIC
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Borland	- Turbo Pascal
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